WICKIE - an in-situ monitoring system to measure groundwater recharge flux, nitrate and DOC concentrations

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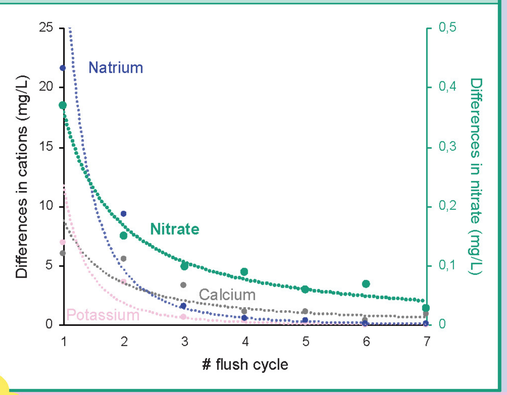
Aims & Set-up

- Groundwater in intensively farmed catchments often becomes polluted, endangering drinking-water supplies.
- Fully on-line, passive sampler that directly measures percolating water in the field and allows water-sample collection or couple with in-situ quality sensors.
- Hanging fiberglass wicks on a horizontally inserted stainless-steel channel (1 m × 0.12 m) create suction – providing a 900 cm² active sampling area while preserving the natural pore structure of surrounding soil.
- Percolation quantification with 3-D-printed PETG tipping-bucket.

Wick Preparation

- Fiberglass wicks were flushed with de-ionized water to wipe out any contaminant build-up.
- After 5 flushing cycles the wicks are contaminant-free.
- Wicks were air-dried post-flush, guaranteeing no extra dilution when they're placed in the soil.



Water Quantity

We installed two WICKIEs at the border between two different landuse types in SW-Germany. Only one soil pit was necessary to obtain comparable data for two diverging crop types.

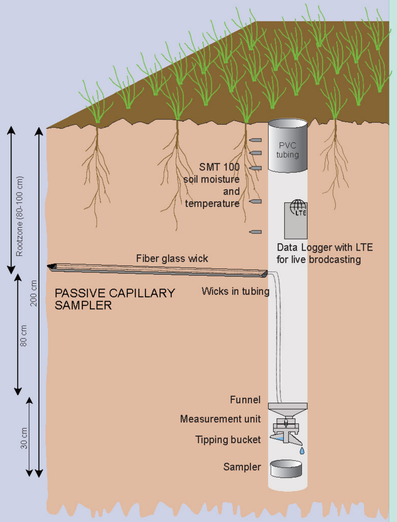
Wicks on stainless steel channel during installation.

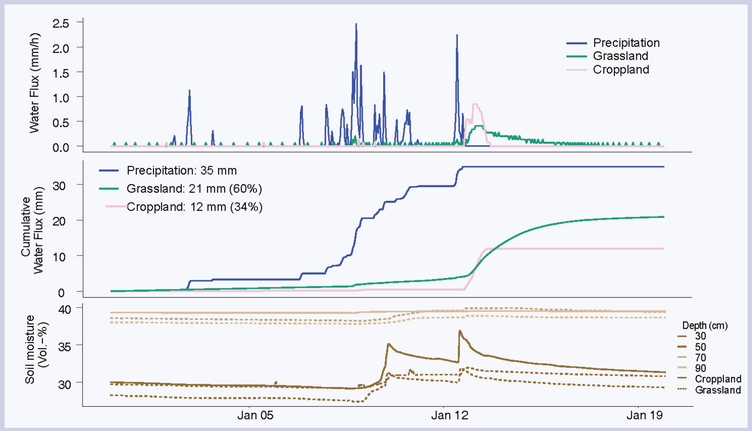
Installed Setup top view.

Soil moisture sensors at 10, 30 and 50 cm depth.

Side view of the installed WICKIE.

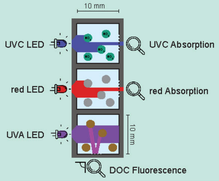
Field site after installation.

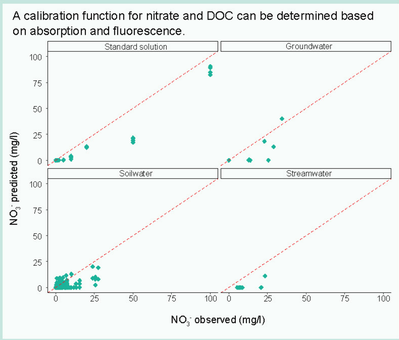


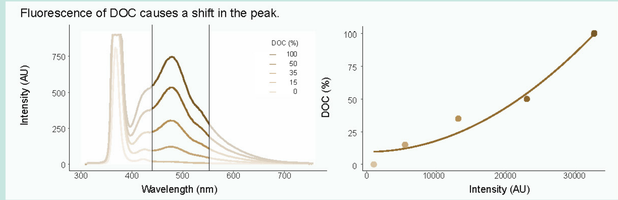


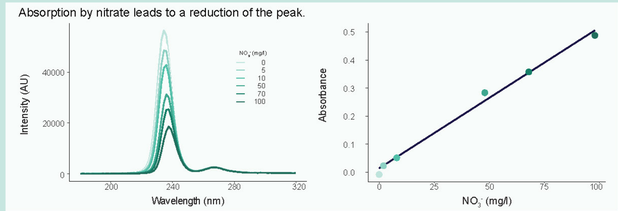
Water Quality

- Using LEDs and photodiodes we measure absorbance (NO_3^-) and fluorescence (DOC) at selected wavelengths, giving on-site concentration data without the need for bulky, expensive spectrometers.
- While not yet as precise as high-end commercial units, the sensor delivers comparable accuracy and strong correlation with laboratory results: making it a practical field alternative.
- DOC and turbidity can skew nitrate readings, calibration is intensive, and sensor response varies from site to site, so further optimisation and site-specific tuning are still required.









Conclusion and relevance for practice

- At a cropping-grassland border in SW Germany, WICKIE captured the exact time lag between rain events and subsurface percolation, delivering high-resolution flux data in real time.
- The system ran for six months without any external power, proving that reliable, continuous monitoring can be achieved in the field with virtually no maintenance.
- By providing continuous, real-time and low-cost measurements of both recharge volume and water-quality parameters, WICKIE equips farmers, hydrologists, and water managers with the data they need for precise groundwater-recharge assessments and smarter, more sustainable aquifer management.

Advantages of WICKIE

Water Quantity

- The area stays passable to heavy farming equipment.
- Shows spatial variability in typical vegetation patterns under agricultural fields.
- Eliminates the need for electric pumps and suction cups.
- Avoids soil saturation typically observed in free-draining lysimeters.
- WICKIE measures leachate volumes at 10-minute intervals.
- Compared to classic lysimeters, WICKIE causes only minimal soil changes, thus avoiding artificial preferential flow paths.

Water Quality

- The optical sensor has the potential to simultaneously measure turbidity, nitrate, and DOC concentrations.
- Alternative to expensive spectrometers that utilize xenon lamps for full spectrum measurement.
- LED-based optical sensor for detecting nitrate absorption in the UV-C range.
- The inexpensive optical sensor delivers good results for nitrate and DOC, which are only slightly worse than those of expensive spectrometer systems.

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LURCH Grundwasser nachhaltig bewirtschaften
FONA Forschung für Nachhaltigkeit
Bundesministerium für Bildung und Forschung